

Chronic nerve compression syndromes (entrapment), peripheral nerve tumors

Chronic nerve compression syndromes (entrapment)

Carpal tunnel syndrome

Syndroma canalis carpi (Carpal tunnel syndrome, CTS) is a compression neuropathy in the wrist. It is the most common entrapment syndrome, the most common mononeuropathy and at the same time the most common occupational disease. The main risk factors include long-term, excessive and unilateral overloading of the hand and wrist, vibration with transmission to the hand, but also diabetes mellitus or thyroid diseases. Subjective symptoms include paresthesia and 1st to 4th finger dysesthesia, and objective symptoms include atrophy of the outer portion of the thenar. Disability is quantified by electromyography. [1]

Incidence

The incidence is reported between 180 and 346 cases diagnosed / 100,000 population per year, with women being affected about 3 times more often than men. The average age of patients is between 45 and 55 years with a predominance of disability in the working population. CTS often occurs bilaterally and the dominant hand is more affected. [1] [2]

It occurs more in older, small women. [3]

Carpal tunnel anatomy

The borders of the carpal tunnel consist of:

- *eminentia carpi ulnaris: os pisiforme, hamulus ossis hamati,*
- *eminentia carpi radialis: tuberculum ossis scaphoidei a tuberculum ossis trapezii,*
- palmar side: *ligamentum carpi transversum* or *retinaculum musculorum flexorum,*
- dorsal side: carpal bones.

The **median nerve and 9 tendons of finger flexors** pass through the tunnel. *Nervus medianus* sends above the carpal tunnel *ramus palmaris nervi mediani* - a sensitive branch for the lateral region of the carp and the lateral part of the palm; therefore, this area is not sensitively affected by CTS. After passing through the carpal tunnel, it sends *rami musculares* to the thenar muscles in addition to the *m. adductor pollicis* and the deep head *m. flexor pollicis brevis*, which are supplied by the ulnar nerve. It also sends *nervi digitales palmares*, which supply motorized *musculi lumbricales I et II* (for the 2nd and 3rd finger) and sensitively the 1st finger to the half of the 4th finger from the palmar side and their innervation extends beyond the tips fingers to the dorsum of the hand, where they sensitively supply the distal parts of the phalanges. [1]

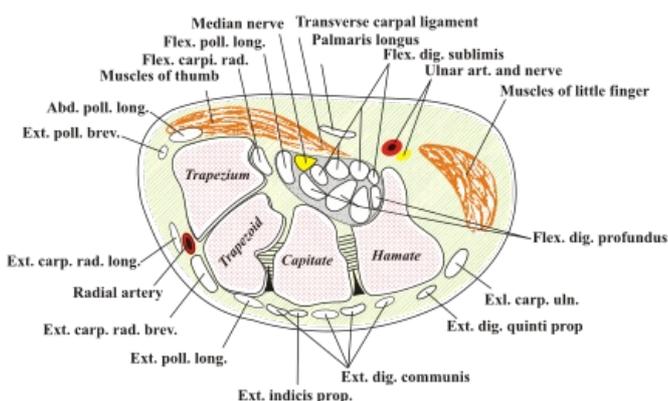
See the *Canalis carpi* page for more information.

Etiology and pathogenesis

The carpal tunnel is strait, so it anatomically predisposes nerves to damage. Any abnormality of the nerve or its surroundings that results in a reduction in the surrounding space, leads to compression of the nerve. First, there is compression of the "vasa nervorum" and thus ischemia of the nerve and its edema, which further increases the pressure on the nerve at the point of passage through the carpal tunnel. Persistent chronic compression of the nerve can then induce structural changes in the nerve (initially a lesion of the myelin sheath, later the involvement of individual axons occurs) with a gradual loss of function of sensitive and motor fibers. Sometimes intraneural fibrosis can occur. Weakly myelinated fibers leading to pain perception are more resistant. [1][4]

Risk factors of CTS development:

- excessive, long-term and one-sided local muscle load of small muscles of the arm and forearm - use of greater muscle strength with lower frequency of movement or less muscular force with high frequency of movement (working with a screwdriver, holding heavier hand tools, playing string instruments, working with computers keyboards and mouses in an inappropriate position) - leads to hypertrophy, trauma to the area and soft tissue edema;
- vibration with transmission to the hands (working with a chainsaw, jackhammer, pneumatic hammer or drill) - leads to microtraumas directly in the nerve, or damage to the *vasa nervorum* with subsequent ischemia of



Carpal tunnel anatomy

nerve fibers;

- diseases that affect the nervous, vascular or fibrous-skeletal system: diabetes mellitus, hormonal changes (thyroid diseases, 3rd trimester of pregnancy - the problems subside within a few weeks after delivery, use of hormonal contraception, menopause, acromegaly), rheumatic diseases (rheumatoid arthritis, Systemic Lupus Erythematosus (SLE)), traumatic changes (fractures of the wrist bones followed by bone marrow formation, Colles fracture), obesity, gout, alcoholism, nutritional deficiencies and many others;
- congenitally narrow carpal tunnel, tendon anomalies, vascular anomalies, ganglion, tumor.^{[1][4]}

Diagnostics

- anamnesis, physical examination and EMG.

Clinical image

- sensitive symptoms appear first:
 - paresthesia ("pins and needles", tingling sensation) or dysesthesia of the 1st to 3rd and adjacent part of the 4th finger on the palmar side of the hand and dorsally around the nails of the same fingers (ie. in the range of sensitive innervation of the n.medianus), sometimes symptoms may affect all fingers (based on anastomoses between n. medianus and n. ulnaris: Martin-Gruber anastomosis on the forearm or Cannie-Riche anastomosis in the palm);^[4]
 - feeling of a "swollen hand" without obvious swelling;
 - initially, typically at night - it wakes up the patient in the morning and after shaking the hand and moving the fingers there is relief, later even while resting during the day;
 - or when working manually, when the wrist is bent in a static hand position (holding the handlebars) or when raising the upper limb (holding on to the handle in a moving public transportation/vehicle).
- mild to severe hypoaesthesia in the area of the 1st to radial half of the 4th finger from the ventral part and on the dorsal fingertips
- deterioration of fine motor skills (problem of turning a button on or picking up a small coin)
- motor symptoms: paresis of an abduction and opposition of the thumb
- in the severe stage, the sensitive symptoms may disappear, atrophy of the small muscles of the thenar is present due to severe denervation
- atypical symptoms include shooting pain from the hand to the forearm, arm or shoulder, or pain in the carp
- fasciculations or spasm of thenar muscles occur rarely
- autonomic symptoms may also appear - temperature changes, discoloration and trophic changes of the skin and nails^[1]



Development of subjective symptoms

1. phase - morning dullness in the fingers;
2. phase - nocturnal paresthesia;
3. phase - diurnal paresthesia - especially when working with hands above a head (for example, holding the handle in public transport);
4. phase - clumsiness of small movements.^[3]

Objective finding

Sensitivity disorders - we assess them on the 2nd finger (we compare the sensation on the "finger belly" of the 2nd and 5th finger).

A Motor defect arises later - mainly atrophies the abductor pollicis brevis;

- we show the sign of the candle - hand palm up, thumb sticking up, we push it into the palm, we monitor its resistance;
- the resulting atrophy of this muscle makes a visible hole laterally on the thenar.

The sensation above the thenar is normal (the subcutaneous branch originates from the median nerve before entering the carpal tunnel!!!).

A **pseudoneuroma of the mediah nerve** is formed - a spindle-shaped thickening of the nerve caused by the compression of the nerve and the accumulation of the axonoplasm.^[3]

Examination

Provocation tests - maneuvers that narrow the space for the nerve in the carpal tunnel:

- hammer or finger tap over carpal tunnel (Tinel test)
- compression with our fingers over the carpal tunnel for 30 seconds (Durkan's test)
- hand flexion in the wrist for 60 seconds (Phalen's test),
- hand extension in the wrist for 60 seconds (reverse Phalen's test)
- hand elevation for 60 seconds (hand elevation test)^[1]

Classification according to the severity of the clinical finding

1. mild degree: intermittent symptoms, only positive provocation tests can be physically equipped, event. hypersensitive response to vibrational stimulus, irritation of *n. medianus* without the presence of fading symptoms;
2. moderate degree: positive provocation tests, muscle weakness, possible hypotrophy of the thenar muscle, decreased vibrational perception in *median nerve* distribution;
3. severe degree: muscular atrophy, sensitive symptoms are permanent, abnormal two-point discriminatory sensation, extinction symptoms are significant.^{[4][5]}

Electromyography (EMG)

- to verify the diagnosis as well as to determine the severity of the disability and to objectively monitor the disease;
- verifies the involvement of sensitive and motor fibers *n. medianus* (neurography) and shows whether the process is chronic, acute or subacute;
- demonstration of demyelinating signs of nerve involvement - reduced rate of sensitive conduction and prolonged distal motor latency (DML), picture of potential dispersion;
- in later stages, evidence of axonopathy - reduction of the amplitudes of the summation action potential of the sensitive nerve (SNAP) and the summation (compound) muscle action potential (CMAP);
- needle EMG - reinnervation potentials (chronic impairment) and abnormal spontaneous activity (acute impairment).^[1]

Imaging methods

- sonography, CT, magnetic resonance imaging - in case of surgery failure or tumor exclusion as a cause of CTS;
- X-ray — if rheumatological disease or bone abnormality is suspected (eg. after trauma).^[1]

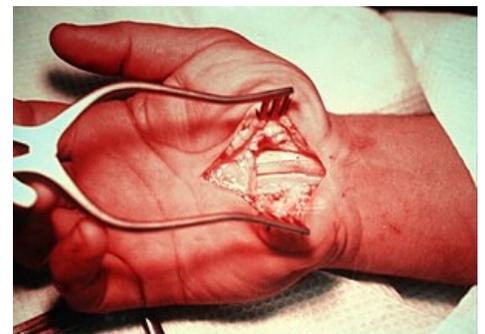
Differential diagnostics

- C6 and C7 radiculopathy - pain projects into the fingers in a banded distribution, deterioration during cervical spine movements;
- pronator tunnel syndrome - pain / tingling in the fingers and hypoaesthesia in the distribution of the *median nerve*, palpation sensitivity in the area of the *m.pronator teres* and, in the case of more severe disability, flexor finger paresis;
- cervical myelopathy - difficulty with fine motor skills of the hands, but then the development of atrophy in the distribution of multiple nerves;
- polyneuropathy — upper and lower limb tingling;
- Raynaud's syndrome — vasoconstriction and vasodilation attacks accompanied by pain and paresthesias of the fingers;
- diseases of tendons, sheath, their attachments and joints;
- stenotic tendovaginitis - so-called bouncing or "magnifying-like" finger;
- thoracic outlet syndrome;
- sometimes it is possible to have some of the diagnoses mentioned above with CTS. ^{[1][4]}

Therapy

Conservative therapy

- causal treatment of the underlying disease;
- reduction of upper limb load;
- middle position of the hand, reduction of flexion and extension of the wrist (soft orthosis or bandage on the wrist at night to maintain the middle position);
- physiotherapy - ultrasound, laser, magnetotherapy, iontophoresis, mobilization of wrist bones, etc .;
- non-steroidal anti-inflammatory drugs generally in combination with topical therapy;
- injection with local anesthetics, steroids or non-steroidal anti-inflammatory drugs;
- group B vitamins.^{[1][4]}



Carpal tunnel operation

Surgical therapy

- moderate to severe disability is indicated according to clinical and EMG findings;
- nerve decompression by discise of *ligamentum carpi transversum*;
- classic open approach (gold standard) or endoscopy;^{[1][4]}
- in LA, this procedure is performed on an outpatient basis;
- there are quite a few complications - insufficient cross-linking of the ligament (insufficient incision, use of the so-called retinaculoma blindly...)^[3]

Cubital tunnel syndrome

Cubital tunnel consists of - *lig. colaterale ulnare* (the scum), medial epicondyle humerus, olecranon and aponeurosis of the *m.flexor carpi ulnaris*.

Etiology

In general, there is an increase in surrounding structures and compression of the ulnar nerve. The most common causes are:

- **after fractures** - hypertrophic muscle is formed
- **occupational load** - long-term flexion in the elbow (glass grinders)



Carpal tunnel scars

Clinical manifestations

- **4th and 5th finger tingling, finger dullness, often up to paresis and atrophy**
- **typical difficulties** - when fastening the belt, fastening the zipper, button
- **in severe cases** - clawed hand and interosseous muscle paralysis

Treatment

- **surgical** - deliberation and nerve transposition before the medial epicondyle

Meralgia paraesthetica

Meralgia paraesthetica is narrowing syndrome, in which there a compression of **n.cutaneus femoris lateralis** (from *plexus lumbalis*) occurs, during its course from pelvis under *ligamentum inguinale* . It is more common in obese people, pregnant women and diabetics.

Manifestations

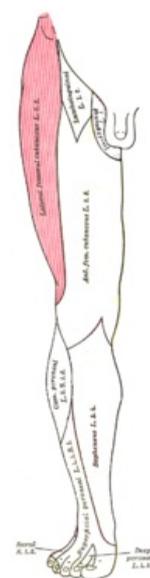
It is manifested by **intense burning pains** and paraesthesia on the outside of the thigh. There may also be a sensory disorder in this area.

The pain is typically relieved by flexion in the hip.

Treatment

The primary measure is to lose weight. In addition, local anesthetics and corticosteroids are injected. Drugs may be given to treat Neuropathic Pain (*carbamazepine, amitriptyline*).

For the duration of the problems, surgical treatment is indicated - nerve release. Its results are often unsatisfactory.^{[3][6]}



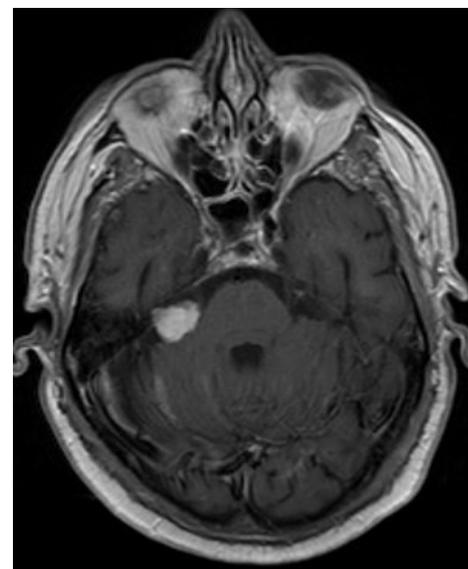
n.cutaneus femoris lateralis

Peripheral nerve tumors

Peripheral nerve tumors can originate from Schwann cells, fibroblasts or perineural cells. The most important representatives include *neurinoma* (schwannoma, neurilemoma), *neurofibroma*, *granular cell tumor*, perineurioma, neurothecoma or malignant tumor of the peripheral nerve sheath (MPNST - malignant peripheral nerve sheath tumor).

Schwannoma

- It occurs either sporadically or as part of **neurofibromatosis type II**.
 - Neurofibromatosis usually involves multiple, chain-like tumors of various sizes on many nerves.
- The tumor usually destroys the fascicle from which it emanates, the other fascicles go after the tumor and are stretched and oppressed.
- They are also of considerable size.
- **Therapy:** the tumor has a capsule, functional fascicles usually separate from the capsule without problems and only the tumor is removed.
 - Paresis may improve over time.
- The histological picture shows two variants of the tumor, referred to as *Antoni variant A and B* . Type A is typical for its seaming of nuclei, such an arrangement is referred to as Verocay bodies. Type B has a rather myxoid character, it does not contain nuclei. Both variants can be found in one tumor.^{[3][7][8]}



Schwannoma on MRI

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